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Consortium de recherche en exploration minérale

# 2013-06: Discrimination of graphitic and sulphidic electromagnetic conductors

This work is the continuation of project 2010-04: *Conceptual re-evaluation of VMS exploration models in the Abitibi Subprovince*, which detailed non-conventional VMS potential in the Abitibi: mafic-type and pelitic-mafic type. The project concluded by proposing new exploration strategies for these types of VMS, targeting EM anomalies in particular. Among the criteria used in conventional "bimodal mafic-type" VMS exploration are "isolated EM anomaly" and "the coexistence of mafic rocks and rhyolites". Conversely, the new strategies propose the investigation of the potential of sedimentary and mafic environments that make up more than 90% of the Abitibi volcanics. Project 2010-04 emphasised the relevance of exploring the EM anomalies in these contexts where they are located along linear conductors formed by graphitic horizons that were previously systematically excluded, and the importance of discriminating between the EM responses of graphitic and sulphidic conductors. Promising preliminary results were obtained using statistical analysis of longitudinal variations of the EM signal correlated with the presence of sulphides. This study aims to continue the work focusing on two main questions: 1) does a deeper analysis of the information contained in each of the channels of the EM signal allow the identification of characteristic signatures that can discriminate between the anomalies caused by graphitic conductors and those caused by massive sulphide lenses?; 2) does the analysis of longitudinal changes in the anomalies contained in the graphitic linear conductors allow the detection of massive sulphide lenses "masked" by the high conductivity of the graphite?

The first question was approached empirically by looking for correlations between the intensity of the dB/dt signal of the 20 receiving channels (5 on-time and 15 off-time), and the geochemical and/or mineralogical characteristics of the conducting interval responsible for the anomaly that was intercepted in drilling. The geochemical analyses used were taken from Hannington (2012; MRD291) and represent sulphidised graphitic argillites sampled according to a protocol attached specifically to target the conducting interval using 1) MEGATEM and 2) petrographic data directly from the drill core. Geochemical indices used, S(%) for sulphide content and C_graph(%) for graphite content, were incorporated into a database with the values from all MEGATEM channels of the anomaly measured directly above the sampled interval. A specific code was programmed to isolate MEGATEM anomalies from drill hole locations, to extract associated geophysical data and to calculate some parameters of the anomalies. Subsequently, the correlations were extensively searched using advanced statistical methods: principal component analysis (PCA) and multiple linear regression (MLR). As a result we can deduce that:

1) The available data do not allow us to conclude categorically if it is possible to distinguish between sulphides and graphite. This is mainly for two reasons: a) the questionable reliability of petrographic criteria for recognising the conducting interval – this issue could be easily resolved by sampling with a conductivity meter, and b) massive sulphides are not present in sufficient quantities.
2) A new parameter, I1, is proposed here. It represents the ratio of middle "on-time" channels over early and middle "off-time" channels. PCA shows that the ratio contains the fundamental variability of the electromagnetic signal, thus this parameter has the

potential for discrimination. It shows a clear correlation with the sulphide content (pyrite, pyrrhotite); however, it is much less influenced by the graphite content.

3) The statistical prediction of the graphitic carbon content of a conductor using MLR from the characteristics of the MEGATEM anomaly is very satisfactory.

To investigate the second question, we compiled data on graphitic horizons located in the Quebec section of the Abitibi where the described mineralised bodies are located and where they were covered by MEGATEM surveys. The linear conductors were identified and the constituent anomalies were analysed to study their longitudinal variability. The objective of the exercise was to test the hypothesis that massive sulphide lenses produce an abnormal signal that differs from the background noise of the graphitic horizon related to changes in graphite and primary sulphide contents. Three parameters were considered: the time constant Tau for the middle channels, the envelope of total energy at channel 12 of field B and the I1 index described above. These parameters express the conductance of the rocky environment relatively independently and are not significantly affected by Quaternary cover. The results are very conclusive: massive sulphide lenses are detected in almost all cases. The hypothesis is therefore true: the overlap of the background conductance of the graphitic horizon and the sulphide lenses with the result that the three parameters stand out clearly higher directly above the lenses than in the rest of the graphitic horizon. The work has enabled a systematic targeting of MEGATEM anomalies potentially associated with the presence of massive sulphides in graphitic conductors in the Abitibi. Eighty-five (85) targets were generated.

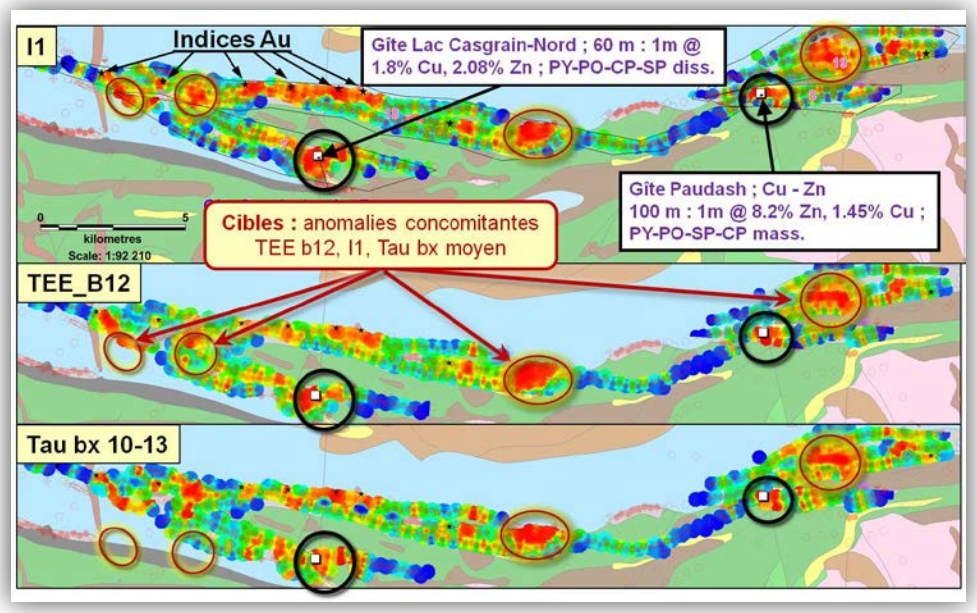


**Figure 1. An example of graphitic horizons in the Selbaie-west sector. Detection of known massive sulphide lenses (Lac Casgrain and Paudash showings) and targets. Note that gold occurrences are also detected. Geology and ore bodies from SIGÉOM 2012.**

| Project 2013-06: Summary | |
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| **Objectives** | • Discrimination by signal processing: using advanced statistical analysis of MEGATEM anomalies to verify the existence of characteristic and distinctive signatures provided by the graphitic and sulphuric conductors.<br>• Discrimination using spatial analysis: to check the possibility of discriminating the two types of conductors by analysing the longitudinal variations of the MEGATEM response along linear conductors.<br>• Define a new MEGATEM interpretation strategy. |
| **Results and Innovations** | • Using principal component analysis to propose a new index (index I1) to assist in the detection of sulphidic conductors.<br>• The available data does not allow the categorical discrimination of sulphides and graphite (specific sampling is necessary).<br>• Analysis of longitudinal variations in the intensity of MEGATEM anomalies, estimated using three geophysical parameters – TEEB12, I1 and TAU – along the graphitic linear conductors containing known showings, demonstrates that it is possible to detect the massive sulphide signal superimposed on the graphitic background.<br>• Development of a systematic targeting of MEGATEM anomalies potentially associated with the presence of massive sulphides in the graphitic conductors of the Abitibi. |